

their weight and speed, and effect of wear and tear on the roads; nationalisation of the roads, and Exchequer grants towards their maintenance; the collection of statistics and standardisation of these.

There can be no doubt that a very considerable change has come about in the requirements of roads since the advent of the motor-car. After the introduction of railways the main roads became very much neglected, and little interest was taken in their condition, but now they are more used than even in the old coaching days. For the traction engine, the motor-car, or the steam trolley the old methods of management are unsuitable, and the new conditions require different treatment. The greater part of the roads in rural districts may be described as having grown or developed, and have been built up by the use of the metalling placed on the surface without any foundation. This accounts for their unsuitableness for the rapid and heavy traffic with which they have now to contend, and for the excessive cost of maintenance.

The old turnpike roads, which constitute the greater part of the main roads now under the control of the county or borough councils, have been, as a rule, well made, and are under the management of qualified engineers, and on these roads considerable attention has been paid in the endeavour to adapt them to the altered circumstances; but on the highways which are under the management of rural district councils the case is different. These rural councils, from a false idea of economy, make use of perishable materials for repairing the roads, such as limestone or gravel, because these can be procured in the neighbourhood, and can be obtained at less price than suitable road material brought from a distance. With the same false idea of keeping down the cost, unqualified men are employed as surveyors at small salaries. Sometimes the only qualification that the applicant for this office possesses is that he has been unsuccessful in his business as a farmer.

In a pamphlet on the repair and management of roads, issued by the Roads Improvement Association for the use of surveyors of highways, it is clearly shown that roads well maintained and kept in good order cost less than bad roads repaired with inferior material. An example is given of a turnpike road which had been much neglected, of which, owing to change of management and the use of granite in place of local stone, the cost was not only considerably reduced, but from the improved surface of the road one horse was able to draw as large a load as formerly required double the number. In the same district it was also shown that the parish roads, which cost the most to maintain, were without exception those that were kept in the worst condition, and that when these were placed under efficient supervision, while the roads improved, the cost of their maintenance diminished.

The use of self-propelled vehicles, owing to the way in which they affect the surface of the roads, more than ever emphasises the necessity for the use of skilled supervision. There was a unanimous expression of opinion at the conference that the cost of maintaining the roads had very considerably increased, and that in many cases, owing to the want of proper foundations or inadequate metalling, they are quite unsuited for the class of traffic that they have now to bear.

In one of the papers read at the congress it was shown that to cover such roads with a coating of suitable material of a thickness of 3 inches, in place of the flint or limestone at present in use, would cost 1100*l.* per mile, or five millions of pounds for the south-eastern division of England, where the motor traffic is the heaviest, and to which the paper more particularly referred.

The cost of maintaining the main roads has been very largely increased owing to the wear and tear of automobiles. During the last nine years the annual cost of the main roads, which extend over a length of 27,600 miles, has risen from 2,024,711*l.* to 2,766,903*l.*, or at the rate of 76*l.* to 100*l.* per mile. In one of the southern counties the cost has been doubled.

A matter that received considerable attention at the conference was the nuisance due to the dust which prevails in dry weather along the roads frequented by self-propelled vehicles moving at great speed. Motor-cars not only raise and distribute dust in a manner previously unknown, but

also are responsible for its production. This is especially the case on the roads that are in the worst state of repair. On a loose surface the fine particles, which act as a binding material to the larger stones, are sucked up by the tyres of the wheels and distributed over the road, causing inequalities and providing material for dust. A great deal of damage is also done by the sucking out of the water from the puddles when the road is wet. A rubber-tired wheel splashing into a puddle sends the water flying out of it with a speed and force greater than any other vehicle, and converts a small puddle into a larger one. This effect is greatest where the surface is repaired with soft material, or where the material used for binding is unsuitable. On roads under the management of unskilled surveyors any material is considered sufficient for binding the larger stones used for covering the surface of the road. The scrapings of the mud off the road in winter are often made use of for this purpose, and in one of the papers read at the conference it is stated that in one district even material was dug from the sides of the road, and the metalling bedded with this. Under such practices the result, of course, cannot be otherwise than a muddy surface in winter and dust in dry weather.

Various processes have been tried as a means for preventing the generation of dust, but the one most generally adopted in this country is to make the surface of the roads waterproof by the use of pitch or tar, either as a matrix for binding the stones together or as a surface dressing. Already 1500 miles have been treated in this way. The best results are obtained where there is a good foundation, and a surface covering of sufficient thickness of the hardest and toughest material, well consolidated by rolling, with just sufficient fine chippings of the same stone to fill the void spaces, the surface being rendered impervious to water or the action of frost by the use of tar or some bituminous material. Tar macadam, which consists either of the whole material used or only of the binding material being mixed with tar before being placed on the road, has been largely used. Opinions varied as to the use of this process. In some cases it has been a complete success, in others a failure. This is probably owing to the manner in which the material has been prepared and laid, and to the quality of the tar or pitch used. To be successful it requires that the material must be mixed with the tar when it is dry, and dry weather is required when it is put on the road. If improperly mixed it either breaks up in patches, which are difficult to repair, or becomes so soft in hot weather as to work into a very uneven surface.

For surface dressing on roads already made and in good condition, spraying with tar either by hand or by a machine made for the purpose is effective, and as it adds considerably to the life of the road it does not add much to the cost of maintenance.

No reference was made in any of the papers to the practice in use in the United States, and which now extends over many hundreds of miles in California and other States, of using petroleum or bituminous oil for spraying instead of tar, which is there found to be very effective. The oil is spread from a specially designed tank-car at a rate varying from one to two gallons to the square yard. Roads so treated are fit for traffic twenty-four hours after being sprayed; they are thus rendered impervious to rain-water, and the surface remains hard and firm in hot weather.

MAGNETIC SURVEYS.¹

THE first volume referred to below may be regarded as the coping-stone of the work done for the Coast and Geodetic Survey by Dr. Bauer during his tenure of the office of chief of division of terrestrial magnetism. Dr. Bauer had actually transferred his services to the Carnegie Institution of Washington before the volume

¹ Department of Commerce and Labour, Coast and Geodetic Survey, United States Magnetic Tables and Magnetic Charts for 1905. By L. A. Bauer. Pp. 154. (Washington: Government Printing Office, 1908.)

Magnetic Survey of the Dutch East-Indies, 1903-7. By Dr. W. van Bemmelen. Pp. 69; with charts. (Batavia: Government Printing Office, 1909.)

Survey of India. Extracts from Narrative Reports, 1906-7. (Calcutta: Superintendent Government Printing, 1909.)

appeared, but the responsibility for the work seems entirely his. The volume represents a complete magnetic survey of the United States for the epoch January 1, 1905, based on observations at 4149 stations, including 3311 in the United States itself, 575 in Canada, 201 in Mexico, and 62 in the West Indies. The great majority of the stations were occupied by Coast and Geodetic observers, but acknowledgments are made to Señor Felipe Valle for results from some seventy of the Mexican stations, and to Dr. King and Prof. Stupart for a good many results from Canada. In the United States the density of the stations varied from one per ninety square miles in Maryland to one per 2924 square miles in Idaho, the average being one per 973 square miles. Details as to instruments, methods, and sites of stations are not given, having been dealt with in previous volumes of the Survey.

Table I., pp. 18-87, summarises all the observations. It gives the name, latitude, and longitude of the station, the date of observation to 0.1 of a year, the observed values of the three elements declination (D), inclination (I), and horizontal intensity (H), the values of the elements reduced to the epoch 1905.0, and, finally, the authority. D and I are given to 0.1, and H to 0.0001 C.G.S. (or 10 γ). The results are grouped under the States of the Union. Table II., pp. 91-5, summarises results obtained at sea in the Atlantic and Pacific Oceans, and in the Gulf of Mexico, at 241 stations, between January 1, 1903, and midsummer, 1907. In this case results are given for total intensity as well as for D, I, and H. Table III., pp. 101-7, shows the secular change in D at eighty stations representing specified portions of different States of the Union. Values of D are given at ten-year intervals from 1750, when available, down to 1900. The values for 1905 and the estimated annual changes at that date are added. Table IV., pp. 114-9, gives secular-change data for D, I, and H for five-year intervals, from 1840 downwards, for forty-seven geographical positions; e.g. twelve have latitude 45° , their longitudes being respectively 65° , 70° , . . . 110° , 115° , and 122.5° W. Table V., pp. 123-150, contains values of D, I, H (along with its north and east components), as well as values of the vertical intensity (V) and total intensity (T), at the intersection of all degrees of latitude and longitude on the North American continent between 17° N. and 49° N. Values of D and I are given to 0.1, values of H to 0.001 C.G.S. These data for D, I, and H are obtained by scaling from the charts, the process not claiming an accuracy exceeding 0.05 in D and I, or 0.0005 in H. The other force elements were apparently computed from these, but they are given to four significant figures.

The first five charts, dealing respectively with D, I, H, V, and T, are each about 28 inches by 22 inches. As to the method of construction of the charts for the three first elements, we are told (p. 153) that "the reduced values for 1905.0 . . . were plotted on a base map of about four times the size of the charts. Next the lines (isogonals, isoclinals, isomagnetics) were drawn to conform as strictly as possible with the plotted results." The V and T charts are based on values calculated by combining values of H and of I scaled from the charts for these two elements. The aim is at least to indicate all local irregularities of any importance, and, as Dr. Bauer truly remarks, "one cannot fail to be impressed by the manifold irregularities shown by the lines." This remark is especially true of the isogonals, but the V and T isomagnetics are also exceedingly irregular in the regions bordering on the great lakes. In the charts, successive D and I lines differ by 1° , successive H, V, and T lines by 0.01 C.G.S. These lines are drawn in red, geographical details being in black. The D, I, and H charts also contain blue lines, drawn to pass through the places where the secular change of the element is the same. In 1905 the agonic line—along which the needle points to the true north—ran from a little to the west of Charleston, in South Carolina, in a north-westerly direction to the north-east corner of Lake Michigan. The line of no secular change ran, roughly, parallel to the agonic line, but about 250 miles to the west of it. To the east of the line of no secular change the needle is moving to the west, and to the west of this line it is moving to the east. The extreme annual change—met with on the Pacific coast—

is only about $4'$. The phenomena, in a general way, are such as would ensue from a southerly movement of the north magnetic pole, and this is in general harmony with the secular changes in the other elements. H is falling and I increasing over nearly the whole United States, except in the extreme north-east, west, and north-west. There have, however, been remarkable changes in the set of the secular change of late years, showing that the real phenomenon is of a very complicated character, which renders any forecast for the future very uncertain.

The two last charts are of a different character from the others. No. 6 shows "magnetic meridians," defined as horizontal lines which have for their tangent at every point the direction of the compass needle. No. 7 gives secular-change curves of two types, one showing the change of absolute direction in space of the freely dipping needle, the other showing changes in the horizontal intensity.

The work is one which merits, and will doubtless receive, close attention from all who are engaged, or are likely to be soon engaged, in magnetic surveys. It is interesting to learn (p. 13) that corrections for diurnal inequality were applied only in the case of the declination. In the case of the inclination and horizontal intensity, Dr. Bauer's opinion seems to be that corrections for diurnal inequality "are, in general, of the order of the error of observation, and certainly much less than the 'station error' due to the irregular distribution of the earth's magnetism." He was presumably influenced, in part, by the consideration that secular change in H varies over the United States from $+20 \gamma$ to -70γ per annum, so that a knowledge of the annual change, even to the nearest 10 γ , must be difficult to acquire in the regions more remote from magnetic observatories. How disturbances are dealt with does not seem to be stated. If Dr. Bauer's views are correct, and they are based probably on a wider experience than that of any other man living, one cannot help thinking that extreme refinement in field instruments or observations may be largely thrown away in the case of a general survey of a large area. If we may borrow and extend a military metaphor, supreme importance attaches, not so much to the gun, or even to the man immediately behind it, as to the general.

In the second volume we have a survey for the epoch 1905.5 of the Dutch East Indies, made under the direction of Dr. W. van Bemmelen, of the Batavia Observatory. The area included extends from Sumatra in the west to the borders of Dutch and German New Guinea in the east (95° to 141° E.), and from Timor in the south to Mandanao (Philippines) in the north (11° S. to 8° N.). The area is thus very big, including much sea and many small islands, in addition to Sumatra, Java, Celebes, and parts of Borneo and New Guinea. There were 158 stations, a considerable number being on the smaller islands, but none at sea; they were occupied during 1903 to 1907. Owing, no doubt, in part to the relatively small number of his stations, Dr. van Bemmelen's practices are in many respects the antithesis of Dr. Bauer's. The former attaches comparatively little importance to the exact site of his stations. On the other hand, though having continuous records from only one observatory, he applies corrections to all the elements to eliminate the diurnal inequality and irregular variations, going to 0.1 in declination and dip, and to 1 γ in horizontal force. The Dutch charts, again, unlike the American, take no account of local peculiarities, but resemble the world charts of the British Admiralty in the bold sweep of their lines. They are drawn on thick paper in the body of the volume, and, again, unlike the American, present quite an artistic appearance.

Dr. van Bemmelen gives the values of the magnetic elements at intersections of degrees of latitude and longitude, going to 0.01 in declination, 0.1 in dip, and to 0.0001 C.G.S. in the total force and in its vertical, horizontal, southerly, and easterly components. He reproduces, with some corrections, the results of two previous surveys of the East Indies, one for the epoch 1848.0, by Captain C. M. Elliot, the other for 1876.5, by Dr. E. van Ryckevorsel, and makes use of these in discussing the secular change. Though representing a much smaller amount of field work than the American, the Dutch survey

presents—as one expects from Dr. van Bemmelen—many ingenious ideas, which, if not all equally valuable, are at least suggestive. Observers in tropical countries, for instance, will be interested to learn how he dealt with mosquito troubles, and how he rendered the beats of his chronometer audible during rain-storms. To those now engaged in the magnetic survey of India, the work must be one of especial interest.

The third volume describes the work done in 1906–7 by the Survey of India. Besides interesting details as to pendulum and tidal work, levelling and ordinary surveying, it gives an unusually full account of the progress of the magnetic survey under Captain Thomas, R.E. As in previous volumes, there is an account of elaborate instrumental investigations, but the most novel part is a discussion of formulæ got out by Mr. J. Eccles—acting, apparently, on a suggestion by Sir A. Rücker—for deducing the diurnal inequalities of declination and horizontal force at any intermediate place from those recorded at two magnetic observatories. There are comparisons of the inequalities observed at one magnetic observatory with those calculated for its latitude and longitude from the inequalities at two other observatories. The agreement is pronounced very satisfactory. The formulæ seem based on the assumptions that the diurnal inequality at a given latitude is a function only of the local time, and that for the area concerned the rate of variation with latitude of the departure at any local hour from the mean value for the day is constant both for the northerly and easterly components of force.

So limited a hypothesis seems hardly likely to prove very satisfactory unless confined to somewhat restricted areas, and when one looks into the observed and calculated values, especially those for the declination, one finds that, *relatively to the amplitude of the inequality*, the agreement is less satisfactory than one would have inferred from the comments made. The declination diurnal inequality, however, in India is so small that even large percentage departures from accuracy would be of minor consequence from a survey point of view.

Various prospective difficulties are referred to in connection with the distribution of magnetic storms, the difference between mean values from all and quiet days, and similar matters. The nature of the answer to several of the problems mentioned might perhaps be anticipated from what is already known from other sources; but one cannot avoid a suspicion that, unless India is singularly free from local magnetic disturbances, some of the difficulties referred to may prove to be of secondary importance. It will certainly require no small amount of knowledge and ingenuity to utilise to the full all the refinements which it is intended to introduce into the observational material.

C. CHREE.

BIRD NOTES.

FROM Dr. Thienemann, director of the Vogelwarte (ornithological station) at Rossitten, on the Baltic, we have received three papers relating to the recent work of that establishment. The first of these, which deals with marked storks and swallows, is an extract from Reichenow's *Ornithol. Monatsberichte* for October, 1908; the second, in which the migration of storks is discussed at some length, was originally published in *Land- und Forstwirtschaftliche Zeitung* for September; while the third, relating to marked storks in Africa, gives no clue as to its place of publication. A note on this third paper appeared in the *Times* of April 5. In connection with these, it may be mentioned that a very interesting article by Mr. A. L. Thomson on the work of the Rossitten station, and more especially the method of marking birds, is published in the April number of Witherby's *British Birds*.

As regards the capture of marked storks in Africa, reference in *NATURE* has been already made to the specimen recently killed in Natal. Dr. Thienemann now tells us of the capture, at Morija, Basutoland, of a Rossitten bird in February last. This is the most southerly point reached by a stork liberated in east Prussia, but the Natal bird, which was set free in Hungary, went further,

although the distance from the point of liberation was less. Other records include a stork, one of a brood of three marked near Königsberg in June, 1906, the ring and foot of which were brought by natives to a French officer near Lake Tchad, the bird having been snared in October of the same year on the Fittri Lagoon. A stork from a brood of three, liberated near Koslin, Pomerania, in July, 1907, was taken the following winter near Fort Jameson, Rhodesia. It is now, therefore, certain that European storks habitually migrate to South Africa, and the next point to ascertain is whether they ever breed south of the equator.

According to the *Times* of April 26, the capture of a marked stork near Jerusalem has been reported to the Hungarian Central Bureau for Ornithology, Budapest. A flock of more than 2000 storks alighted to rest by one of the lakes near Jerusalem, and five were caught. The marked bird was hatched at Egri, in eastern Hungary, last season, and marked with the stork-ring No. 293 on July 8, 1908; it will be placed in the new Palestine Museum. The storks seen were on their homeward journey, probably from South Africa. This capture is considered important as showing that these birds do not pass over the Mediterranean Sea, but follow the longer route over the land.

That the South African honey-guides (*Indicatoridae*) are parasitic in the matter of egg-laying has been long known, but it appears from a paper by the Rev. Noel Roberts in the April number of the *Journal of the South African Ornithologists' Union* that this habit is shared by certain members of the whydah-bird group (*Ploceidae*). From a paper in vol. iii., No. 1, of the same journal, it seems that this parasitic habit has been demonstrated in the case of the pied whydah-bird (*Vidua principalis*), and in the issue now before us Mr. Noel gives reasons—although these are not quite so clear or convincing as they might be—that the same holds good in the case of the typical species of the genus *Quelea*. In the author's opinion, this bird deposits its eggs, at all events in some instances, in the nests of another member of the same family, namely, *Pyromelana oryx*. It may be hoped that further investigations will be undertaken for the purpose of confirming these interesting observations.

Nature for April contains a paper, by O. J. Pettersen, on the habits and distribution of the redbreast.

In the course of his annual report on Norfolk ornithology, published in the April number of the *Zoologist*, Mr. J. H. Gurney comments on the scarcity of nightingales, spotted flycatchers, willow-wrens, and various kinds of warblers during the summer of 1908. This scarcity the author attributes to the great snowfall which took place on April 23 of that year. Three features in the autumn migration were noteworthy, namely, the number of redstarts on September 23, the great flights of rooks, crows, and starlings on October 18 and 19, and the abundance of woodcock.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—An anonymous benefactor has expressed his willingness to contribute a sum of 500l., if required, to supplement the 500l. which the Senate has already voted towards defraying the cost of the Darwin commemoration.

Prof. Woodhead has been re-appointed as the representative of the University of Cambridge on the council of the Lister Institute of Preventive Medicine.

At the Congregation on Thursday, May 13, the following Grace will be offered to the Senate:—That there be established in the University a professorship of astrophysics, and that such professorship be governed by the following rules:—(1) the professorship shall be called the professorship of astrophysics, and shall terminate with the tenure of office of the professor first elected; (2) it shall be the duty of the professor to promote by research and teaching the study of astrophysics; (3) the professor shall receive no stipend from the University; (4) the special board of studies to which the professor shall be assigned shall be the special board for physics and chemistry.

Major P. G. Craigie, C.B., will deliver the Gilbey